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External Consultant Involvement for Organizational Capability Building in Complex Construction Projects: A Perspective from Inter-Organizational Learning Process

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ABSTRACT:

External management consultants have been increasingly employed by the owners of complex construction projects (CCPs) to foster management innovation and improve their organizational capability. However, the dynamics of owner-consultant collaboration process in such projects are still unknown. To bridge this gap, this paper aims to explore the roles of external consultant involvement in fostering management innovation and developing an organizational capability in CCPs. Based on survey data collected from 102 such projects across different types in China, the partial least square- structural equation modeling analysis results uncover the positive effect of external consultant involvement in creating management innovation and building organizational capability. In particular, the mediating role of management innovation is identified in the exploration and transformation learning processes with external consultants involved. The findings of this study not only provide a novel explanation to the creation of management innovation in CCPs through external consultant involvement, but also useful guidance to project owners to identify and utilize external consultants better in future.

AUTHOR KEYWORDS:

External consultant; complex construction project; organizational capability; management innovation.

INTRODUCTION

An increasing number of complex construction projects (CCPs) have been initiated and implemented over the past two decades – such as high-speed railway lines, airports, mega-event sites, and business complexes – to enhance the urbanization and economic sustainability of many countries (Flyvbjerg 2017). Managing these, especially one-off, projects poses a significant challenge for their owners, due to their accelerating investment scales, complicated design, and external complexity derived from their prevailing and ever-changing environments. In addition to some owners choosing to develop an in-house capability to manage their projects, an increasing number of owners have become inclined to employ external consultants and work with them to develop their organizational capability and ensure smooth project delivery (Engineering News-Record 2019). According to the *Engineering News-Record* (2010 & 2019), the total revenues of the top 50 program management consultants – a kind of management consulting service – around the globe increased from USD 8.93 billion in 2010 to more than USD 14 billion in 2019.

Although Rasdorf et al. (2010) observed this important emerging trend a decade before and affirmed the research significance and potential for exploring the issues in this area, it is only recently that have studies begun to examine owner-consultant collaboration interactions, processes, and dynamics, which are believed to be a key to the successful delivery of CCPs. Based on a triangulated exploratory study in China, Wen et al. (2017) concluded that management consultants have become an important stakeholder in managing CCPs and serve as the owner's agent to execute part of the owner's management work. In addition, they emphasized that the successful collaboration between owners and consultants depends largely on the extent of knowledge transfer and sharing across organizational boundaries, which would shape their capability integration. From the perspective of management innovation, in addition to professional experts and service provided, external consultants can create new knowledge, experience, and practice to help focal organizations foster management innovation and develop their organizational capability in conducting complex undertakings (Mol and Birkinshaw 2014; Ferreras-Méndez et al. 2016).

A deep understanding of this phenomenon in CCPs can be further leveraged by the process view of absorptive learning, which can conceptualize interactions between owners and external consultants as a three-route exploratory, transformative, and exploitative learning process at the inter-organizational level (Lane et al. 2006). Especially in the context of complex projects, absorptive learning can not only help cope with project complexity and sustain desired performance (Bjorvatn and Wald 2018), but also contribute to organizational control through management innovation (Love et al. 2016). In addition, absorptive learning can help uncover the imbalanced roles of the three different learning processes used to acquire external knowledge, and further explain why not all organizations employing external consultants can do so in a similarly efficient manner. Based on these analyses, we assume that external consultant involvement in CCPs involves an interaction with their external counterparts by the three learning processes (exploratory, transformative, and exploitative), thus contributing to creating management innovation and developing organizational capability. This is important for CCPs because of its strong proclivity to engage external consultants in creating management innovation due to its demand for knowledge management and the emerging trend for open innovation in the business world. Therefore, by focusing on CCPs, we argue that owners need to pay attention to different externally-involved learning processes to create management innovation, thereby improving organizational capability and sustaining efficiency.

This study extends extant theory by investigating the impact of external involvement on inter-organizational learning processes in CCPs, which is shaped and driven by the interactions between owners and their consultants. In particular, this work aims to answer both theoretically and empirically the question of how external involvement affects management innovation in CCPs through the three learning processes.

THEORETICAL FRAMEWORK

Management Innovation, External Consultant Involvement, and Organizational Capability Building

Management innovation provides an important way to handle complexity challenges and sustain desired efficiency in complex projects (Davies 2017). In contrast with manufacturing industries, where most innovation research has been carried out, management innovation in CCPs mainly involves new information technology, processes, and systematic methods introduced from other industries or projects to a new project's management system and organization that are innovative to the owners (Shields 2019). As noted by March and Simon (1958, pp.188), the "majority of innovations are the result from borrowing rather than those from invention". Nevertheless, how management innovation can be achieved in complex projects remains an important issue to be addressed. Until recently, it has been recognized that external consultants (e.g., designers, technical consultants, management consultants, and universities) can provide reliable stable external-knowledge acquisition and reduce the focal organization's burden of acquiring external knowledge (Ferreras-Méndez et al. 2016). Just as emphasized by Mol and Birkinshaw (2014), engaging external consultants can provide an external experience, and their direct involvement helps management innovation through underlying learning processes as an aid to improving organizational capability to cope with specific complicated tasks.

The roles and function of management consultants in CCPs have received increasing research attention in the past decade due to the rapid development in the area. For instance, Rasdorf et al.'s (2010) empirical U.S. industrial survey of external management consultants (e.g., external program managers) affirmed the importance of this trend, and that would have positive effects for potential owners of complex projects. Wen et al. (2017) further evaluated the role of management consultants, finding it positively impacted on responsibility delegation and capability integration. In addition, several case studies, such as the Shanghai Expo site construction, have revealed a variety of positive results from engaging external management consultants, such as production innovation, process improvement, and enhanced delivery efficiency (Davies et al. 2017; Hu et al. 2015). Despite these efforts, the roles of external consultants in introducing and facilitating management innovation in complex projects remain unclear.

Another important issue for management innovation research in complex projects is organization capability, defined as the reliable capacity that is created and exercised to accomplish project goals and objectives with its intended action (Schienstock 2009). This is similar to its role in creating organizational competence, which is crucial to overcoming project complexity and sustaining required performance (Davies et al. 2017; Hu et al. 2015). Although the positive impact of management innovation on organizational capability has long been recognized by numerous research studies (Davies et al. 2017; Hu et al. 2012; Roehrich et al. 2019), a systematic evaluation is still lacking on the relationships between management innovation with external consultants involved in organizational capability building.

In response, this study builds a theoretical framework by integrating two theoretical branches of the management innovation literature to guide an empirical analysis. The first branch refers to the theory of externally-involved management innovation, which explains the creation of management innovation in CCPs by acquiring new knowledge, experience, and practice from external consultants. The second branch refers to the process view of absorptive capacity, which conceptualizes the external involvement process in CCPs into three-route learning processes used to acquire, absorb, and utilize absorbed knowledge, experience, and practice. This view likewise leverages a theoretical lens into inter-organizational interactions and discrepancies in the different learning processes in organizational capability building through external involvement.

Externally-involved Exploratory Learning Process

As noted by Davies (2017) and Zhang et al. (2021a), exploratory innovation is common in large projects, which leads to the emergence of exploratory learning. Especially in the case of CCPs, most owners lack relevant experience and choose to employ external management consultants: thus, exploratory learning with external consultants involved is needed to obtain external knowledge. Fundamentally, exploratory learning refers to a process of knowledge acquisition, which is dominated by two sequential activities of external knowledge recognition and assimilation (Ferreras-Méndez et al. 2016). The former refers to the establishment of scanning mechanisms adopted by firms to recognize external knowledge sources, while the latter refers to activities undertaken by firms to integrate external knowledge into their knowledge bases (Ferreras-Méndez et al. 2016). With these activities, subsequent knowledge applications can improve when the details of all the problem-solving methods are captured.

In the current turbulent and rapidly changing environment, exploratory learning across organizational boundaries provides an important vehicle for organizations to achieve innovation and superior performance (West and Bogers 2014). Furthermore, promoting exploratory learning in projects can be affected by environmental conditions, especially in the rapidly changing project environment resulting from the relatively long execution period of complex projects. In this case, exploratory learning has become extremely important for managers of CCPs in building organizational capability and achieving project success, which helps them acquire existing outside knowledge and achieve management innovation (Davies et al. 2017). Thus, the following hypotheses are proposed for CCPs:

H1a. Externally-involved exploratory learning contributes to the creation of management innovation in CCPs.

H1b. Externally-involved Exploratory learning contributes to organizational capability building in CCPs.

Externally-involved Transformative Learning Process

Transformative learning refers to the retention of knowledge over time. It comprises two core activities: namely, maintaining assimilated knowledge and reactivating knowledge (Lane et al. 2006; Ferreras-Méndez et al. 2016), which can bridge the gap between exploratory and exploitative learning. This issue has been underestimated in previous studies of management innovation in complex projects. Nevertheless, several studies in other areas have carried out pilots exploring the topics and found that a paradigm of transformative learning will usually emerge in undertaking innovative tasks through inter-organizational collaboration (Melnychuk et al. 2021). In addition, collaborating with external consultants can help firms overcome ambiguity and uncertainty in maintaining internal knowledge (Ferreras-Méndez et al. 2016), which results in externally-involved learning across organizational boundaries. In the context of CCPs, fostering management innovation usually involves a relatively long process of transformation (Roehrich et al. 2019). Similarly, fostering management innovation through management consultants in CCPs needs to take time to retain and distribute knowledge to enable the emergence of transformative learning. Thus, we propose the following hypotheses:

H2a. Externally-involved transformative learning contributes to management innovation creation in CCPs.

H2b. Externally-involved transformative learning contributes to organizational capability building in CCPs.

Externally-involved Exploitative Learning Processes

Exploitative learning usually co-exists with exploratory learning in the contexts of projects, especially where multiple projects are involved (Zhang et al. 2021a). It refers to a process of matching and use of knowledge and technologies on the market to achieve commercial benefits for firms (Ferreras-MÉNdez et al. 2016). This often happens when executing the assimilated knowledge and guaranteeing knowledge reuse, including: (a) knowledge from a sub-project being reactivated and assimilated into managing other sub-projects when the complex project is divided into several sub-projects and executed separately, and (b) external knowledge, experience, and technology from similar projects or other sources being transferred to a newly-starting project (Davies et al. 2017).

Exploitative learning that matches and uses existing knowledge in collaboration with external consultants emerges in complex projects, because it can help apply assimilated knowledge in innovations and achieve high performance. Davies (2017) argues that project performance can be increased through exploitative learning because firms undertake 'similar' categories of projects in mature or new product markets, involving repeatable and predictable patterns of activities. Similar to that in enterprise management (Ferreras-Méndez et al. 2016), exploitative learning in complex projects can be divided twofold: namely, transmutation and application. These two activities are critical because their absence causes a negative effect like that caused by the lack of complete knowledge matching and reuse. In the context of CCPs, external consultants usually have first-hand knowledge and experience obtained from prior similar and successfully completed projects and can transfer them to the current owner (Davies 2017), which may lead to exploitative learning that reuses existing knowledge rather than attempting to reinvent it. In addition, exploitative learning caused by the engagement of external consultants is found to enhance organizational capability development in such extreme forms of CCPs as megaprojects (Hu et al. 2015). Thus, we propose the following hypotheses:

H3a. Externally-involved exploratory learning contributes to management innovation creation in CCPs.

H3b. Externally-involved exploratory learning contributes to organizational capability building in CCPs.

In the context of CCPs, almost all management innovation is devoted to improving design and production, thereby ultimately contributing to their smooth accomplishment (Davies et al. 2017). That is, externally-involved management innovation can strongly effect the formation and exercise of organizational capability. Thus, we assume the hypothesis:

H4. Externally-involved management innovation can contribute to organizational capability building in CCPs.

Mediating Role of Absorbed Management Innovation in Organizational Capability Building

As noted by Davies et al. (2017), organizational capability building occupies a pivotal role in dealing with the challenges faced by complex projects. Not all absorptive learning processes aimed at creating management innovation can contribute to organizational capability building. Such an improvement can only be made when absorbed management innovation with an emphasis on management efficiency improvement can be obtained through a certain kind of learning process (i.e., exploratory, transformative, and exploitative) or mixed ones (Wright et al. 2012). Thus, we further hypothesize that:

H5a. Absorbed management innovation can mediate the relationship between externally-involved exploratory learning and organizational capability building in CCPs.

H5b. Absorbed management innovation can mediate the relationship between externally-involved transformative learning and organizational capability building in CCPs.

H5c. Absorbed management innovation can mediate the relationship between externally-involved exploitative learning and organizational capability building in CCPs.

Figure 1 summarizes all the above hypotheses.

(Please insert Figure 1 here)

Methodology

An empirical survey was used to deduce the relationships between the externally-involved organizational learning processes, absorbed management innovation, and organizational capability in CCPs. This research design was deemed appropriate as it provided an objective lens for the underlying relationships between the five constructs of the model (Ferreras-Méndez et al. 2016; Wen et al. 2017). The research process included three steps: namely, questionnaire design, data collection, and data analysis.

Questionnaire Design

To increase reliability, the types and locations of CCPs in which the respondents were involved were included in the questionnaire. Four control variables of project cost, project types, design complexity, and environmental complexity were included in the proposed model. Regarding the five constructs, 31 measurement indicators were first identified by reviewing the related literature. In addition, the selection and adjustment of measurement items regarding each construct were supplemented with interview feedback from 10 industrial practitioners to make sure the measurement items used in the questionnaire were easily understandable to industrial professionals in the targeted sectors, thereby ensuring content validity. As a result, some was deleted either because of their overlapping in content with other items or because of their being inappropriate in the construction project context. Table 1 shows all measurement items used to measure the five constructs.

(Please insert Table 1 here)

Sample Description and Data Collection

As there is no official list of large construction projects involving external management consultants in China, it was not possible to estimate the size of the overall population for probability sampling. Instead, the triangulated use of non-random and random sampling strategies was adopted through different sources (Wen et al. 2017; Zhou et al. 2018). First, we disseminated questionnaires to owners and consultants involved in several well-known projects (e.g., the Shenzhen city's Qianhai new district and Shanghai Hongqiao Airport) either through on-site visits or through the assistance of Tongji University's Research Institute of Complex Engineering and Management, the Hongkong-Zhuhai-Macao Bridge Authority, Shanghai K&Z Construction Project Management Corporation, and their partners. Both hardcopy and online questionnaires were provided for the convenience of the survey participants, resulting in approximately 60 responses. Recognizing this limited sample size, further survey invitations were sent to all participants in the 1st to 5th

Executive Development Programs for *Full-process Engineering Consultancy and Corporate Development* held between August 2018 and April 2019 by the Tongji University School of Economics and Management. This is a one-week training program, held every 1-2 months, mainly designed for project owners and consulting professionals by voluntary registration. The data collected from these participants used external management services and followed the random sampling strategy. All respondents were asked to evaluate the questionnaire issues in terms of personal involvement in a CCP with a cost of more than CNY 100 million (USD 14.3 million) based on a five-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree") (Podsakoff et al. 2003). Finally, 123 valid responses were returned. As Table 2 shows, these projects were located in 17 provinces, municipal cities, and autonomous regions and accounted for more than a half of all province-level regions in mainland China. Compared with Wen et al.'s (2017) pilot survey with a sample size of 82, the sample size in this work was deemed to be sufficiently large.

(Please insert Table 2 here)

Measurement Item Development

Three independent variables of externally-involved exploratory learning (Ext_explorat_learn), externally-involved transformative learning (Ext_transform_learn), and externally-involved exploitative learning (Ext_exploit_learn) were used to capture interactions between owners and external consultants in absorbing management innovation. This operationalization was adopted in terms of the widely advocated organizational learning models, involving the three dimensions of processes (e.g., Jansen et al., 2005) (Table 1). Five items were used for measuring each of the three kinds of interactions.

The mediating variable was absorbed management innovation (manage_innov). For this construct, four measurement items were abstracted from complex project management literature (Luo at al. 2017) and used to assess how much externally-involved learning contributes to absorbed management innovation at the organizational level.

All constructs were operationalized with reflective rather than formative mode (Diamantopoulos et al., 2008). due to the items used to measure each construct are positively correlated ones (Coltman et al., 2008).

Data Analysis Process and Methods

The data analysis process included two steps:

First, a preliminary data analysis was undertaken. Mean value replacement was used for missing measurement item values, and case-wise replacement was used when the amount of missing data surpassed 15% and the data was not systematically missing. As the respondents comprised two groups – namely, owners and consultants – a preliminary two-tailed *t* test was conducted to examine the agreement in their perceptions of the measurement items.

Second, partial least squares-structural equation modeling (PLS-SEM) was adopted to conduct the main data analysis, as it is concerned with testing the proposed theoretical framework from a prediction perspective (Hair et al. 2019). This method can assess the potential relationships between measurement items and their affiliated constructs and among different constructs using several estimated parameters based on a combination of PCA, path analysis, and regression analysis (Hair et al. 2019). The PLS-SEM analysis is more suitable than other covariance-based SEM methods because of the relatively small sample size and data characteristics (Hair et al. 2014). The SmartPLS V3.2.8 software was used to conduct an ordinary least squares (OLS) analysis to assess the significance of the path coefficients, coefficients of determination (R^2), and predictive relevance (Q2). A path-weighting analysis was performed with bootstrapping to produce the path coefficients for testing the hypotheses.

The validity and reliability of the measurement model were assessed in terms of measurement reliability, construct dimensionality, and discriminant validity as suggested by Hair et al. (2019). *Measurement reliability* was mainly evaluated in terms of composite reliability (CR), with an additional exploratory factor analysis conducted to examine the potential cross-loadings. *Construct dimensionality* was assessed by checking the loading value of each measurement item on its first-order factor, and the loadings of the first-order factors on the second-order factors. *Discriminant validity* was mainly evaluated in terms of three indicators –namely, the average variance extracted (AVE), correlation matrix, and variance inflation factors (VIFs) (Hair et al. 2014) – analyzing the results of the individual correlation scores against their related reliability. The outer VIFs were also computed to evaluate multi-collinearity.

The potential impact of the four control variables was evaluated through bootstrapping analysis as suggested by Gnec et al. (2019) and Hair et al. (2019). This involved a setting of 500 resamples to compute the standard errors, *p* values, and path coefficients in the structural model. The variations in the endogenous constructs in the structural model were first evaluated by the variance explained R^2. As suggested by Hair et al. (2014), the R^2 threshold should be determined in terms of sample size, model complexity, and the specific research area involved. The mediating effect of absorbed management innovation on the links between the three different learning processes and organizational capability was tested through the bootstrapping procedures with the aid of SmartPLS software (Genc et al. 2019).

Common Method Variance

As a single-informant and self-reported survey was used to collect the data, the evaluation of the potential common methods variance (CMV) was required. First, the Harman one-factor test was conducted on the six first-order latent variables (Podsakoff and Organ 1986), with the potential CMV explored following the comprehensive analysis strategy as suggested by Williams and McGonagle (2016). After evaluating the validity results of the measurement model, the baseline model was established and another model including the method variable used to test the method effects.

ANALYSIS RESULTS AND FINDINGS

Preliminary Analysis Results

Before combining the data collected by the two methods, a preliminary *t* test indicated no significant differences at the 0.05 level (She et al. 2017) between the data obtained through non-random and random sampling except for *X9*, *X10*, and *X15*, which were eliminated for subsequent analysis. Thus, the data regarding the remaining 28 measurement items could be triangulated for subsequent analysis (Wen et al. 2017). In addition, due to variations in the owners' and consultants' perceptions of the measurement items (Appendix Table), the results of the two-tailored *t* tests showed the three measurement items of *X1*, *X3*, and *X13* had significant differences at the 0.05 level and were therefore eliminated for subsequent analysis. With only four missing measurement items, the missing data ratio was much lower than the maximum threshold of 5% (Hair et al. 2019).

Measurement Model and CMV Results

As Table 3 shows, all constructs had a satisfactory CR value ranging from 0.838 to 0.928. The result showed no significant cross-loadings (<0.48) in the data set, which indicated the measurement model had desired internal consistency. All measurement items had a factor loading greater than the threshold value of 0.50 ($p<0.05$), indicating a significant level of construct dimensionality.

(Please insert Table 3 here)

As Table 4 shows, the square roots of AVE regarding all constructs was larger than any other value of correlations with other constructs. Thus, all reflective measurement constructs had satisfactory discriminant validity. As Tables 3 and 4 also show, the CR values regarding all constructs were larger than any individual correlations, thereby ensuring discriminant validity. All constructs had a value ranging from 1.000 to 3.584, which is lower than the threshold value of 10, indicating that multi-collinearity risk was unlikely to exist in the proposed model.

(Please insert Table 4 here)

The result of the Harman one-factor test indicated that the first factor explains the 42.41% of total variance, which is lower than the maximum threshold of 50% but is generally acceptable. The results validity results of the measurement model also demonstrated that the ratio of average variance of all indicators in the average method-based variance was almost 584, while most of the method factor loadings were not significant. Thus, it was contended that CMV was unlikely to be present.

Structural Model and Hypothesis Testing Results

Figure 2 shows the structural model results, with R^2 values of absorbed management innovation construct and organizational capability construct in the structural model of 0.344 and 0.577, respectively. That is, the constructs of the proposed model accounted for approximately 34% of the variance in absorbed management innovation, and 58% of organizational capability. Based on an evaluation of the complexity in this model and a similar study by Ferreras-Méndez et al. (2015), both were accepted as moderate.

(Please insert Table 5 and Figure 2 here)

As Table 5 shows, the two hypotheses relating to externally-involved exploratory learning have different results. H1a was supported at the 0.05 significance level, but not H1b, indicating that only externally-involved exploratory learning had a positive effect on absorbed management innovation. Table 5 also provides the test results of H2a and H2b regarding externally-involved transformative learning; similarly, only H2b was supported because its path coefficient was significant at the 0.05 level. The analysis results were $\beta = -0.017$ for project cost, $p>0.05$; $\beta=0.090$, $p>0.05$ for project type; $\beta=-0.015$ for technological and design complexity, $p>0.05$; and $\beta=-0.052$ for environmental complexity, $p>0.05$. Thus, none of these variables had a significant impact on organizational capability.

Table 5 and Figure 2 also show the results regarding externally-involved exploitative learning. H3b was supported because the path coefficient was significant at the 0.01 level. This indicates that learning had a positive effect on organizational capability building.

Figure 2 shows that absorbed management innovation had a significant effect on organizational capability with $\beta= 0.606$ ($p>0.01$), which provided support for H4. That is, absorbed management innovation contributed to organizational capability building in CCPs.

As Table 5 shows, the two hypotheses of H5a and H5c were supported. For H5a (Ext_explorat_learn→ Manage_innov→ Organ_capab), the direct effect was 0.255 ($p<0.05$), the indirect effect was 0.06 ($p<0.05$), and the total effect was 0.606 ($p<0.01$), which confirms the mediating role of absorbed management innovation in the link between externally-involved exploratory learning and organizational capability. For H5c (Ext_exploit_learn→ Manage_innov→ Organ_capab), the direct effect was -0.012 ($p<0.01$), the indirect effect was 0.25 ($p<0.01$), and the total effect was 0.61 ($p<0.01$), which confirms the mediating role of absorbed management innovation in the link between externally-involved exploitative learning and organizational capability. In contrast, H5b was not supported due to its non-significant indirect effect (indirect effect=-0.008, $p>0.05$). These indicate that management innovation serves a partial mediating role in building organizational capability for CCP development.

DISCUSSION

Although the complexities embedded in construction projects having attracted increasing attention (Luo et al. 2017), few studies addressed how to deal with the complexities involved. The findings of the present study provide a novel perspective of the issues by offering insights into an emerging strategy at the industry level. Three theoretical implications are apparent.

First, this work contributes to stakeholder management research in construction by uncovering the role of external management consultants in introducing management innovation and improving organizational capability, which has been seldom addressed in prior studies. As emphasized by Mol and Birkinshaw (2014) and Ferreras-Méndez et al. (2016), the engagement of management consultants has been advocated as a strategic option to enhance the needs of management innovation and respond to environmental turbulence across different industries (Mol and Birkinshaw 2014; Ferreras-Méndez et al. 2016). In line with this perspective, the results of this work not only reinforce prior findings – that external management consultants can exert the responsibilities delegated by owners (Wen et al. 2017) – but also indicate that they could help owners acquire new knowledge and foster management innovation. This, therefore, contributes to project organizational capability improvement, which provides a novel explanation for the rapidly emerging trend of utilizing external management service. In particular, engaging external consultants in CCPs can help owners develop organizational capability through the introduction of management innovation rather than simple responsibility delegation.

Second, the study contributes to the rapidly developing research into construction innovation (Sepasgozar et al. 2018; Zhang et al. 2021a, 2021b), especially that involving management innovation. Three organizational learning processes with external management consultants and their impact on management innovation formation are identified, and the mediating role of management innovation is found between the learning processes and organizational capability building in CCPs. This echoes previous findings, in that management innovation is critical to organizational capability building in large complex projects (Davies 2017). In addition, the results reinforce recent findings relating to ambidextrous innovation in construction projects by revealing two related underlying learning processes of exploration and exploitation (Zhang et al. 2021a).

Third, the study contributes to research into inter-organizational collaboration in complex construction projects by depicting owner-consultant interactions in the three organizational learning processes (Roehrich et al. 2020), which were unknown in previous studies of inter-organizational collaboration. Specifically, the various effects of external consultant involvement are identified along the different externally-involved learning processes on organizational capability building through the mediation of management innovation in CCPs. In particular, the undermined role of externally-involved absorptive learning in large complex projects in prior studies has been identified. It is believed that most CCP owners are 'one-off' in nature and may have little interest in storing related knowledge for further use, which may undermine their activeness in participating in transforming learning. However, the result of this work indicates that this kind of learning still exists in CCPs due to its potential contribution to organizational capability building through the mediation of management innovation. This finding has strong implications for owners in employing external consultants.

CONCLUSIONS

This study has explored the various effects of external management consultant involvement in improving organizational capabilities in CCPs. The results indicate that the exploratory, transformative, and exploitative learning processes with external consultants involved have varied effects on organizational capability building through management innovation. The theoretical implications of this work are threefold. First, knowledge of the strategic role of external consultant involvement in managing CCPs is advanced through management innovation. Second, the contribution to the rapidly developing research into construction innovation is achieved by revealing the externally-involved absorptive learning processes. Third, the contribution to research into inter-organizational collaboration in CCPs by depicting owner-consultant interactions along the three organizational learning processes is made.

There are also several practical implications for practitioners. First, uncovering the positive roles of management innovation in developing organizational capability provides an interesting explanation to the emergence of the use of external management consultants in CCPs around the world. Thus, owners in those CCPs should consider the innovation capacity and experience of management consultants in their selection. Second, the study suggests that this strategy is efficient when all externally-involved learning processes can contribute to management innovation creation, and then ultimately to organizational capability building. Nevertheless, given the commonly changing project requirements and environmental conditions involved, project complexity requires project owners to cautiously implement management innovation, which can only be enhanced through a timely adjustment embedded in different learning processes. Third, in recognition of the construction industry around the globe having been undergoing digital transformation due to the rapid development of digital technology (e.g., Building Information Modeling, cloud computing, and Internet of Things), management consultants need to strengthen their ability to utilize new technology to help owners develop organizational capability.

This work is the first attempt to examine the underlying collaboration mechanism between owners and their consultants in CCPs and, although the measurement items regarding externally-involved learning provide a general support for the proposed model, they are limited to some extent and have potential for future improvement. A further limitation is that collecting all the survey data at one point in time might trigger a potential threat in the deduction of causality, indicating the need for a future longitudinal study to provide further validation of this study's results.

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Table 1 Construct measurement summary

Code	Item description	Sources
	Externally-involved Exploratory Learning (Ext_explorat_learn)	
X1	The owner can observe the application potential of new knowledge and technologies.	Adapted from and inspired by Arbussa` and Coenders (2007), and Ferreras-Méndez et al. (2016)
X2	The owner often identifies new knowledge and technological trends through consultants.	
X3	The owner periodically makes communications with its consultants to acquire new knowledge, methods and technologies.	
X4	The owner employs consultants to acquire new knowledge and technologies.	
X5	The Owner often collaborates with its consultants to apply new knowledge and technologies through internal change.	
	Externally-involved Transformative Learning (Ext_transform_learn)	
X6	The owner makes a regular communication on internal issues with its consultants.	Adapted from and inspired by Arbussa` and Coenders (2007), Ferreras-Méndez et al. (2016)
X7	The owner collaborates with its consultants to establish a project control.	
X8	When encountering a new problem, the Owner is inclined to seek for consultants' assistance to solve it quickly.	
X9	The owner maintains a good collaboration with its consultants with project progressing.	
X10	The owner collaborates with its consultants to predict and analyse project progress and risks and makes a response if necessary.	
	Externally-involved Exploitative Learning (Ext_explorat_learn)	
X11	The owner is proficient in transforming new knowledge and technologies with the assistance of its consultants.	Adapted from and inspired by Todorova and Durisin (2007), and Ferreras-Méndez et al. (2016)
X12	Consultants can help their owner solve the problems and overcome the barriers caused by the use of new technology and knowledge.	
X13	Consultants frequently share relevant knowledge and technologies within the owner organization.	
X14	The owner often applies new knowledge, technologies and solutions provided by consultants.	
X15	The owner constantly considers how to better exploit the consultants' technologies and resources in a collaborative way.	
	Management Innovation Absorbed (Manage_innov)	
MI1	Increase the use of new technology to enhance management efficiency.	Formulated in terms of Luo et al. (2017)
MI2	Increase the use of new methods to enhance coordination efficiency.	
MI3	Provide management training and support required by the owner.	
	Organizational capability (Organ_capab)	
OC1	Improve an overall control of project objectives to reduce execution risk.	Formulated in terms of Davies et al. (2017), and Hu et al. (2015)
OC2	Improve the coordination of project participants to reduce potential conflicts.	
OC3	Improve an execution control in terms of optimized organization and processes.	
OC4	Improve the participation of project participants to stimulate their proactivity.	

Table 2 Profiles of the survey participants and complex projects involved

Profiles	Categorization	Number	Percentage
Stakeholder role	Owners	29	23.5%
	Consultants	94	76.5%
Education	Associate degree or below	4	3.3%
	Bachelor degree	86	69.9%
	Master degree or above	33	26.9%
Gender	Male	101	82.1%
	Female	22	17.9%
Age	Less than 25 years old	7	5.7%
	26-35 years old	35	28.5%
	36-45 years old	49	39.8%
	46-55 years old	30	24.4%
	More than 55 years old	2	1.6%
Working experience in the construction industry	1-5 years	14	11.4%
	6-10 years	26	21.1%
	11-20 years	41	33.3%
	more than 20 years	42	34.2%
Project locations	Northeast China	1	5.9%
	East China	6	35.3%
	Central China	5	29.4%
	West China	5	29.4%
Types of complex construction projects involved	Highways, bridges, and transport infrastructure	14	13.7%
	Airports	8	7.8%
	Cultural and education	15	14.7%
	Energy and hydropower	2	2.0%
	Commercial, exhibition and manufacture facilities	19	18.7%
	Utilities and environmental and public facilities	36	35.3%
	Residential property and industrial parks	8	7.8%

Note: The number of project locations refers to that of provinces, municipal cities, and autonomous regions in each greater region where the sampled projects located.

Table 3 Measurement model results

Construct/measurement	Loadings	*t* value	Cronbach's Alpha	AVE	CR
Ext_Explorat_learn	—	—	0.794	0.710	0.880
X2	0.784	13.564		—	—
X4	0.912	46.931		—	—
X5	0.827	16.777		—	—
Ext_Transform_learn	—	—	0.738	0.656	0.851
X6	0.837	21.548		—	—
X7	0.847	20.464		—	—
X8	0.742	9.933		—	—
Ext_Exploit_learn	—	—	0.710	0.633	0.838
X11	0.828	26.864		—	—
X12	0.827	20.365		—	—
X14	0.729	11.044		—	—
Manage_innov	—	—	0.883	0.811	0.928
MI1	0.908	38.682		—	—
MI2	0.936	71.377		—	—
MI3	0.856	29.29		—	—
Organ_capab	—	—	0.749	0.568	0.840
OC1	0.807	18.785		—	—
OC2	0.686	9.365		—	—
OC3	0.764	17.49		—	—
OC4	0.753	16.534		—	—

Table 4 Correlational matrix

Construct	1	2	3	4	5	6	7	8	9
1.Cost	1								
2. Type	-0.242	1							
3. Techn_design_complexity	-0.049	-0.107	1						
4. Environ_complexity	-0.02	-0.069	0.378	1					
5. Ext_explorat_learn	0.064	0.057	0.078	0.298	***0.842***				
6. Ext_transform_learn	0.007	0.149	0.172	0.284	0.713	***0.810***			
7. Ext_exploit_learn	0.094	-0.005	0.214	0.316	0.583	0.616	***0.796***		
8. Manage_innov	0.031	0.001	0.25	0.286	0.485	0.422	0.551	***0.901***	
9. Organ_capab	-0.011	0.125	0.177	0.183	0.373	0.479	0.546	0.703	***0.754***

Note: Italic bold numbers on the diagonal are the square root values of the AVE.

Table 5 Path analysis results

Hypotheses	Sample mean	Standard deviation	T statistics	Inner VIFs	Direct effect	*p* value	Indirect effect	*p* value	Total effect
H1a. Ext_explorat_learn → Manage_innov	0.254	0.111	2.292	2.184	0.255	0.025	–	–	0.255
H1b. Ext_explorat_learn → Organ_capab	-0.213	0.115	1.814	2.283	-0.201	0.095	–	–	-0.201
H2a. Ext_transform_learn → Manage_innov	-0.001	0.111	0.113	2.324	-0.012	0.000	–	–	-0.012
H2b. Ext_transform_learn → Organ_capab	0.273	0.092	2.914	2.325	0.248	0.058	–	–	0.248
H3a. Ext_exploit_learn → Manage_innov	0.403	0.11	3.737	1.727	-0.012	0.911	–	–	-0.012
H3b: Ext_exploit_learn → Organ_capab	0.178	0.093	1.876	2.283	0.198	0.008	–	–	0.198
H4. Manage_innov → Organ_capab	0.598	0.066	9.001	1.525	0.606	0.000	–	–	0.606
H5a.Ext_explorat_learn → Manage_innov → Organ_capab	–	–	–	–	0.255	0.033	0.062	0.042	0.606
H5b.Ext_transform_learn → Manage_innov → Organ_capab	–	–	–	–	-0.012	0.910	-0.008	0.912	0.606
H5c. Ext_exploit_learn → Manage_innov → Organ_capab	–	–	–	–	-0.012	0.001	0.248	0.001	0.606

Appendix Table. Mean comparison and T-test of the two groups

Item code	Mean			Significance of T-test
	Owners	Consultants	Total	
X1	3.931	3.394	3.520	0.043
X2	3.690	3.394	3.463	0.912
X3	3.793	3.452	3.533	0.050
X4	4.103	3.511	3.650	0.071
X5	3.586	3.096	3.211	0.742
X6	3.724	3.447	3.512	0.820
X7	4.103	3.796	3.869	0.068
X8	4.000	4.108	4.082	0.651
X9	4.172	3.872	3.943	0.041
X10	4.172	3.688	3.803	0.001
X11	4.172	3.957	4.008	0.985
X12	4.138	3.840	3.911	0.181
X13	3.931	3.585	3.667	0.007
X14	3.897	3.606	3.675	0.122
X15	3.966	3.543	3.642	0.003
MI1	4.034	3.862	3.902	0.299
MI2	3.897	3.798	3.821	0.292
MI3	3.862	3.660	3.707	0.692
OC1	4.103	3.809	3.878	0.651
OC2	4.034	3.947	3.967	0.666
OC3	3.931	3.904	3.911	0.735
OC4	3.690	3.681	3.683	0.823

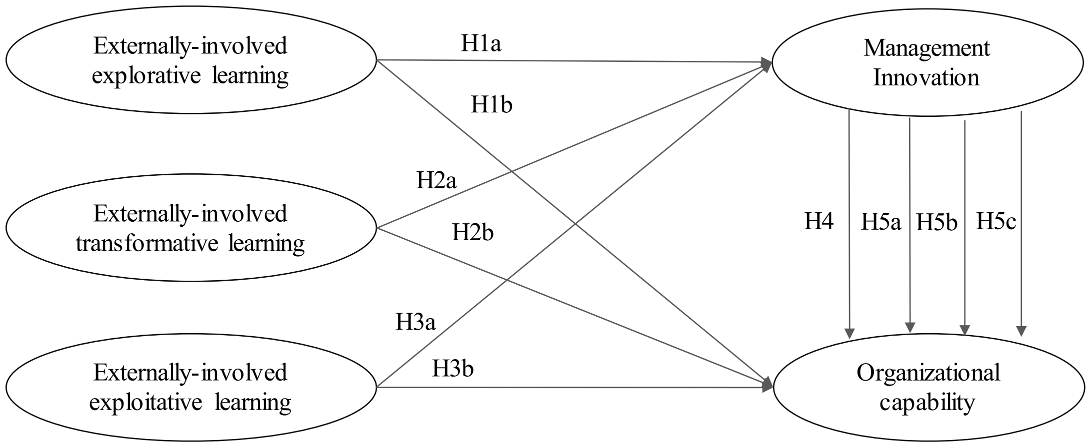

Figure 1. The hypothesized model

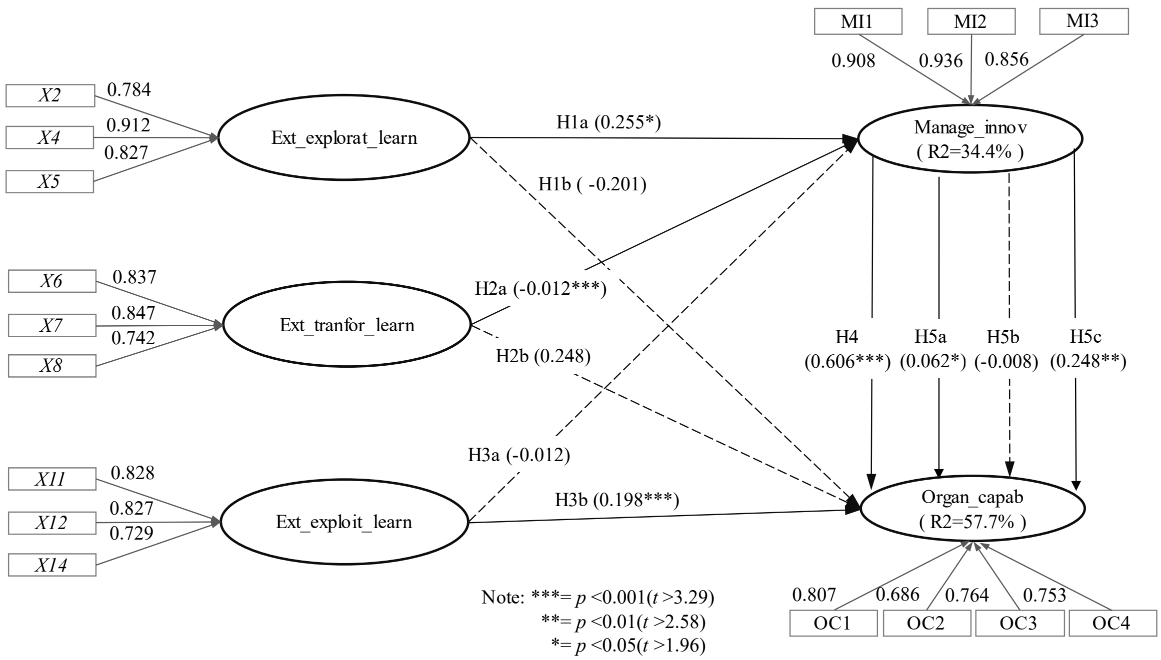

Figure 2 Structural model results